

### Tuning Transmitter Antennas & Patch Cable Lengths

The below information is provided to assist agencies that install 700 MHz mobile units for use on the Utah Mobile Data Network.

#### **700 MHz Mobile Radio Installation**

For maximum power out and minimum power reflected back to the radio, please use the instructions below when performing a mobile radio installation.

1. The Radiall/Larsen antenna recommended for Mobile Data Network (MDN) installations (NMO3E700B) is tuned for 50-ohms, lowest VSWR at 770 MHz. The mobile unit transmitters operate from 794-804 MHz. The antenna should be centered on the band below 1.3:1 VSWR

**Cut the antenna to shift the center of the frequency to 799 MHz where the transmitter is operating. Cut below the coil, 2 7/8".**

2. Most of the THRULINE® meters used by ITS technicians are Telewave 44A meters. Telewave, Inc. confirmed that one wavelength of cable (RG8, RG213, RG214, etc.) is 6.5" including the connectors.

**Use a patch cable length of 13". The patch cable is the cable used in line from the radio to the antenna to check output power and VSWR.**

**A multiple of a half wavelength of cable will not affect the transmitter when the cable and wattmeter are removed after tuning the transmitter to the antenna (see Background Information below).**

3. The antenna that connects to the radio transmitter should be the NM03E700B using low loss cable.

**Do not connect the dual 700 MHz and GPS antenna (GPSCW3E700) to the transmitter.**

4. Antenna spacing for diversity should be located from front to back on the vehicle.

**For best performance, antennas should be placed on the roof or highest vehicle surface with 11.2", 19.1" or 26.7" between the antennas, center to center. The further apart the better.**

#### **Background Information**

In 1964 J. Raymond Bird (founder of what is now Bird Electronic Corporation) published an article discussing how to eliminate changes in transmission system conditions after a THRULINE® wattmeter is removed from a line after adjustments are completed with the instrument inserted in the line.

THRULINE® instruments are directional insertion wattmeters for 50-ohm RF coaxial transmission lines. They measure RF power flow in either direction accurately under **any** load condition.

Since the instrument with its two connectors has a voltage standing wave ratio (VSWR) of less than 1.05, any error contributed by its insertion in a line is negligible (less than 0.06%). When a THRULINE® is used to match a load to a transmitter and a good match is obtained, removing the instrument will not cause any changes in the conditions. This holds true because a good 50-ohm load can be placed at the end of a 50-ohm transmission line of any length without altering the conditions of the transmitter.

When the load is not well matched, like an antenna with a VSWR of 1.5 or 2.0, things change. Since the length of the line between a mismatched load and the source transforms the impedance of the load as seen at the source, line length becomes critical. If the adjustment for maximum power transfer were made with the THRULINE® in place, removing it shortens the line by 4 inches, plus two connectors. This is no cause for concern at lower frequencies, where 4-5 inches is a small fraction of the wavelength. At higher frequencies (e.g., above 100 MHz), both power output and frequency of the source will be affected.

It is a principle of transmission line theory that impedance is identical on either side of one-half wavelength. In order to duplicate the conditions in a transmission line with a THRULINE® either in or out of the line, it is necessary to insert or remove one-half wavelength. This is done by using a length of cable which, when added to the THRULINE®, equals one-half wavelength (or multiple of) including the meter at the frequency of the measurement.